WHAT IS CLAIMED IS

1. A high resolution transducer for non-contact electromagnetic testing, comprising:

a. an insulator body;

b. a ferrite core inserted in said insulator body and having a tapered end, said core characterized by a magnetic permeability and operative to provide a focused magnetic field flux;

c. a high frequency (HF) coil disposed around said core operative to induce multi-frequency, multi-amplitude electromagnetic (EM) field excitations in said core, said excitations further inducing corresponding eddy currents in a tested element; and

d. a direct current (DC) mechanism operative to optimize said magnetic permeability of said core, correlated with a transducer operating regime,

whereby the transducer enables non-contact multi-frequency, multi-amplitude testing of single-layered and multi-layered printed circuit boards that reveals layer defects with high three-dimensional resolution.

2. The transducer of claim 1, wherein said DC mechanism includes a DC coil disposed around said core.

3. The transducer of claim 1, wherein said DC mechanism includes means to supply a DC bias to said HF coil.

4. The transducer of claim 1, further comprising a ferrite ring surrounding said core, said ferrite ring operative to prevent magnetic flow dissipation.

5. The transducer of claim 1, wherein said operating regime is characterized by a maximal core magnetic permeability that provides a high transducer resolution.

6. The transducer of claim 1, wherein said transducer operating regime is characterized by a high transducer sensitivity.

7. The transducer of claim 1, further comprising a protective ring located on said core around said tapered end, said protective ring used to protect said tapered end from damage.

8. The transducer of claim 7, wherein said protective ring is a metallic ring operative to shield and further focus said magnetic field flux.

9. The transducer of claim 2, wherein said tapered end is conical, ending in a substantially sharp point.

10. The transducer of claim 2, further comprising a ferromagnetic varnish coating on at least one of said coils.

11. A transducer for non-contact electromagnetic testing of a printed circuit board (PCB) comprising:

a. an excitation mechanism operative to induce multi-frequency, multi-amplitude eddy currents in the PCB, said eddy currents providing three-dimensional PCB data; and

b. an direct current (DC) based transducer regime setting mechanism operative to provide at least two different operating regimes of the transducer, thereby improving a parameter of the transducer..

12. The transducer of claim 11, wherein the transducer includes a rod-type ferrite core characterized by a magnetic permeability correlated with said operating regimes, said core having a tapered end facing said PCB, wherein said excitation mechanism includes a high frequency (HF) coil disposed around said core operative to induce multi-frequency, multi-amplitude EM fields excitations in said core, said excitations further inducing corresponding eddy currents in the PCB, and wherein said regime setting mechanism includes a DC bias mechanism operative to change said magnetic permeability of said core.

13. The transducer of claim 12, wherein said DC bias mechanism includes a DC coil disposed around said core.

14. The transducer of claim 13, wherein said DC bias mechanism includes means to supply a DC bias to said HF coil.

15. The transducer of claim 11, wherein said parameter is selected from the group consisting of tansducer sensitivity and transducer resolution.

16. A non-contact printed circuit board (PCB) electromagnetic testing system comprising

a. at least one transducer operative to induce multi-frequency, multi-amplitude eddy currents in a tested PCB, each said at least one transducer including a direct current (DC) mechanism operative to provide an optimal transducer operating regime, said induced eddy currents resulting in a frequency dependent electromagnetic field with a normal component that carries PCB output information;

b. a multi-frequency generator for providing AC and DC signals to said at least one transducer; and

c. an acquisition and processing mechanism for processing said PCB output information.

17. The system of claim 16, wherein each said at least one transducer includes an elongated ferrite core with a tapered end for providing a sharp focus to an inspection point having a depth of focus on said PCB, said core having a length axis substantially perpendicular to said PCB and facing with said tapered end a first side of said PCB, and wherein said operativenes to induce multi-frequency, multi-amplitude eddy currents in a tested PCB is facilitated by an high frequency (HF) coil disposed around said core, said HF coil having a coupled impedance created by said normal component of said electromagnetic field.

18. The transducer of claim 17, wherein said DC mechanism includes a DC coil disposed around said core.

19. The transducer of claim 18, wherein said DC mechanism includes means to supply a DC bias to said HF coil.

20. The system of claim 16, further comprising, for each said at least one transducer, an external electromagnetic concentrator positioned in close proximity on an opposite side of said PCB and substantially aligned with said at least one transducer length axis, said concentrator operative to increase the concentration of a magnetic field formed by said transducer core and improve said focus and said depth of focus.

21. The system of claim 17, wherein said tapered end is conical, ending in a substantially sharp point.

22. The system of claim 17, wherein each said at least one transducer further includes:

i. an insulator body surrounding said core,

ii. a ferrite ring surrounding said core, said ferrite ring operative to prevent magnetic flow dissipation, and

iii. a protective ring located on said core around said tapered end, said protective ring used to protect said tapered end from damage.

23. The system of claim 20, further wherein said alignment between said at least one transducer and said external concentrator is provided by a rigid connection.

24. The system of claim 20, wherein said external concentrator is substantially similar in shape to said core.

25. The system of claim 20, wherein said external concentrator has a shape selected from the group consisting from a linear, razor-shape ferrite line, and a flat ferrite substrate.

26. The system of claim 16, wherein said PCB is a multilayer PCB in which each layer has two sides, and wherein said PCB output information includes individual data from each said side of each said layer.

27. The system of claim 26, wherein said individual data is obtained through a subtraction and normalization procedure involving at least two adjacent said sides.

28. The system of claim 26, further comprising means to process said output information in parallel.

29. The system of claim 26, further comprising means to process said output information in series.

30. A non-contact electromagnetic method for printed circuit board (PCB) inspection comprising the steps of:

a. providing at least one transducer operative to apply multi-frequency, multi-amplitude excitation EM fields to the PCB board, said excitation EM fields inducing corresponding eddy currents in the PCB board layers, each said transducer further characterized by having an elongated ferrite core ending in a tapered end, and a direct current (DC) mechanism operative to to set at least one transducer operating regime;

b. using said DC mechanism to set one said transducer operating regime;

c. applying said multi-frequency, multi-amplitude EM fields to obtain said corresponding eddy currents, each of said eddy currents providing a separate frequency sense signal; and

d. processing said sense signals, thereby obtaining high resolution, three-dimensional data revealing defects and other faults in the PCB.

31. The method of claim 30, wherein said operativeness to apply multi-frequency, multi-amplitude EM fields to the PCB board is facilitated by an alternating current (AC) high frequency (HF) coil that doubles as a sensing coil, said HF surrounding said core.

32. The method of claim 30, wherein said DC mechanism includes a DC coil disposed around said core.

33. The method of claim 31, wherein said DC mechanism includes means to supply a DC bias to said HF coil.

34. The method of claim 30, wherein at least one transducer is a single transducer, wherein said step of applying includes applying said multi-frequency, multi-amplitude EM fields includes applying simultaneously two modulated carriers of different amplitudes and frequencies and obtaining said sense signals in the form of one difference signal, and wherein said step of processing said sense signals includes processing said difference signal to obtain depth resolved information that is compared with a virtual or a physical PCB standard.